Lectures and Reading Assignments:

Readings are from “An Introduction to QFT” by Peskin and Schroeder (PS); “Quantum Field Theory” by Srednicki (Sr); “Quantum Field Theory in a Nutshell” by Zee (Z).

1. Lec 23, 4/29 (Tue): Spontaneous Breaking of Global Symmetry. Goldstone’s Theorem. PS Sec. 11.1; Sr Sec. 30, 32
2. Lec 24, 5/01 (Thu): Spontaneous Breaking of Gauge Symmetry: the Higgs Mechanism. PS Sec. 20.1; Sr Sec. 84, 86
3. Lec 25, 5/06 (Tue): Quantization of Theories with Spontaneously Broken Gauge Symmetry. \( R_\xi \) Gauge. PS Sec. 21.1; Sr Sec. 85

Problems:

1. Problem 11.2 (a,b). [Note: The mechanism of fermion mass generation through Yukawa coupling to a scalar field with a vev is used in the Standard Model: all fermions get their masses via coupling to the Higgs field!]

2. Consider the theory defined in Problem 11.2, but promote the global symmetry in eq. (2) to a local (gauge) symmetry, introducing an abelian gauge field \( A_\mu \) with gauge coupling constant \( e \).

   - List the Feynman rules of this theory.
   - Write down the expression for the tree-level invariant matrix element for the scattering process \( \psi(p_1) + \bar{\psi}(p_2) \rightarrow \psi(p_3) + \bar{\psi}(p_4) \) in a general \( R_\xi \) gauge. Show that while some of the diagrams are \( \xi \) dependent, the dependence on \( \xi \) cancels out in the sum: i.e., the matrix element is gauge invariant.
   - What is the condition on \( e \) and \( g \) under which the massive gauge boson can decay into a pair of fermions, \( A \rightarrow \bar{\psi}\psi \)? Assuming this condition is met, compute the width \( \Gamma \) of this decay, at tree level, using the unitary gauge.

3. Problem 20.1